

# Free-Forming With Soybean Oil

**W**hoever said “the present is the future” might have watched automobile pioneer Henry Ford, who once grew soybeans on land owned by Ford Motor Company. His vision was to find ways to use soybean oil and meal in parts for his automobiles.

ARS has a long and successful history of developing technologies to increase markets for U.S. soybeans. After countless new findings and developments from soybeans, there is still something new.

Researchers at the National Center for Agricultural Utilization Research (NCAUR) in Peoria, Illinois, and from the University of Arizona in Tucson, have developed polymer slurries containing soybean oil for use with a new technology for making parts or other objects without using molds. The technique is called solid free-form fabrication.

Solid free-form fabrication technology builds materials by the repetitive addition of thin layers of slurry, which in this case contains soybean oil, fiber, and

a gelling agent. The building process is controlled by a computer program that contains specifications for the desired object.

The system functions like a three-dimensional pen plotter. A motorized syringe is filled with slurry and then mounted on an x-y drive. The computer program tells it to “write” out a thin stream of slurry as it moves over a support surface and traces out the first layer of the object. The syringe then moves up one step and writes the next layer. Successive layers form a solid part after curing.

Sevim Z. Erhan, ARS chemist and head of the Oil Chemical Research Unit, and postdoctoral research associate Zengshe (Kevin) Liu have made this technique environmentally attractive by substituting biodegradable soybean oil for petroleum-derived resins.

“Soybean oil can replace the lion’s share of petroleum-based resin used in parts manufacturing,” says Erhan.

They developed polymer slurries using soybean oil as a base for making composites. Combining soybean oil with glass, carbon, or mineral fibers produces composites just as strong as those made from petroleum-based resins—for less cost.

USDA has applied for a patent on behalf of inventors Erhan, Liu, and Paul D. Calvert of the University of Arizona at Tucson. The rationale behind the research is to promote use of renewable resources like soybean oil to replace petroleum-derived raw materials for industry. Both commercially and environmentally, soybean oil is a good choice.

“The polymers we formulated will work with molds as well as without molds. In working without molds, we simply fill a syringe with the slurry and begin the computer program. If the object is intricate, like a toy soldier, and it requires support before it’s finished, we can use water-soluble polymers to support it, then wash away the surface polymers on completion,” says Erhan.

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Postdoctoral research associate Zengshe Liu uses a tensile strength device to test the properties of a soy-based composite.

The researchers are seeking an industrial partner to conduct feasibility studies of the technology for making parts for automobiles or heavy equipment.

The United States has an abundance of soybeans. U.S. farmers produce over 12 billion pounds of soybean oil annually, and the surplus often exceeds 1 billion pounds. Only 300 million pounds of soybean oil are used in industrial applications. But that figure may greatly expand, along with an overall increased demand for soybeans as new uses—such as solid free-form fabrication—expand.—By **Linda McGraw**, ARS.

*This research is part of Quality and Utilization of Agricultural Products, an ARS National Program (#306) described on the World Wide Web at <http://www.nps.ars.usda.gov>.*

*Sevim Z. Erhan is in the USDA-ARS Oil Chemical Research Unit, National Center for Agricultural Utilization Research, 1815 N. University St., Peoria, IL 61604; phone (309) 681-6532, fax (309) 681-6340, e-mail [erhansz@ncaur.usda.gov](mailto:erhansz@ncaur.usda.gov).* ♦

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A soy-based polymer slurry being tested by chemist Sevim Erhan can be used with or without molds to make small toys or manufacturing parts.